

Amendments to the Claims

Please amend the pending claims as follows:

1. (currently amended) An apparatus for monitoring in real time the movement of a plurality of substances in a mixture, having at least one fluid layer, along an axis of flow, the apparatus comprising:

an X-ray scanner, wherein said X-ray scanner performs a plurality of scans of the mixture over a monitoring period to produce a plurality of scans, wherein a plurality of scan data sets are derived from said scans and wherein said X-ray scanner comprises a sensor array having at least two image rings, each of said image rings arranged serially along an axis of flow; and

control means arranged to analyze the scan data sets to identify volumes of each of the substances and to measure their movement.

2. (currently amended) The apparatus according to claim 1 wherein the apparatus produces a scan data set relating to said at least one fluid layer of the mixture.

3. (currently amended) The apparatus according to claim 2 wherein the control means determines defining a plurality of volume elements in said layer and using uses a measure of the X-ray attenuation in each of said volume elements to form the scan data set.

4. (currently amended) The apparatus according to claim 2 wherein the control means uses the scan data sets to determine the an amount of at least one of the substances in said at least one fluid layer.

5. (currently amended) The apparatus according to claim 4 wherein the control means uses the scan data sets from each of the scans to determine a time averaged value of the amount of said at least one substance.

6. (currently amended) The apparatus according to claim 2 wherein the control means scanner is arranged to produce scan data sets relating to more than one a plurality of layers of the mixture, wherein the layers are in-different positions from each other.

7. (currently amended) The apparatus according to claim 6 wherein the control means is arranged to use the scan data sets relating to said plurality of layers to measure movement of at least one of the substances.

8. (currently amended) The apparatus according to claim 7 wherein the control means is arranged to track a the movement of regions of said substance through the plurality of layers to determine a flow velocity of said substance.

9. (currently amended) The apparatus according to claim 1 wherein the control means is used to measure a the movement of a region of a first substance, to determine a measure of the buoyancy of said region relative to at least one other substance, and to measure a the movement of said at least one other substance using the movement of said region and said buoyancy.

10. (currently amended) The apparatus according to claim 1 wherein the control means defines comprises a model used to calculate a parameter of movement of the plurality of substances on the basis of a number of variables; to produce a measured value of the parameter from the scan data sets; and to determine at least one of said variables from the measured value and the model.

11. (currently amended) The apparatus according to claim 1 wherein the control means is used to determine a flow rate of at least one of the substances, the flow rate being defined as the amount of said substance flowing through a predetermined region in a predetermined time.

12. (currently amended) The apparatus according to claim 1 wherein the control means is used to analyze a scan data set in two stages, wherein a first stage provides a relatively lower spatial resolution and higher contrast resolution.

13. (canceled)

14. (canceled)

15. (previously presented) The apparatus according to claim 1 wherein the scanner is placed around a pipe to measure the movement of the substances through the pipe.

16. (currently amended) The apparatus according to claim 1 further comprising display means for displaying an image of the mixture generated controlled by the control means.

17. (previously presented) The apparatus according to claim 16 wherein the display means displays a video image of the mixture.

18. (currently amended) A method of monitoring in real time the movement of a plurality of substances in a mixture, the method comprising:

performing a plurality of X-ray scans of the mixture over a monitoring period to produce a plurality of scans wherein a plurality of scan data sets are derived from said scans and wherein said X-ray scans are performed using a sensor array having at least two image rings, each of said image rings arranged serially along an axis of flow; and

analyzing the data sets to identify volumes of each of the substances and to measure their movement.

19. (currently amended) A method according to claim 18 wherein each scan produces a scan data set relating to a layer of the mixture.

20. (currently amended) A method according to claim 19 further comprising defining a plurality of volume elements in said layer and using a measure of the X-ray attenuation in each of said volume elements to form the scan data set.

21. (currently amended) A method according to claim 20 wherein the scan data sets are used to determine the amount of at least one substance in said layer of the mixture.

22. (currently amended) A method according to claim 21 wherein the scan data sets from each of the seams are used to determine a time averaged value of the amount of said at least one substance.

23. (currently amended) A method according to claim 19 18 wherein said scan data sets are produced relating to a plurality of layers of the mixture, wherein the layers are in different positions from each other.

24. (currently amended) A method according to claim 23 wherein the scan data sets relating to said plurality of layers are used to measure movement of at least one of the substances.

25. (original) A method according to claim 24 wherein the movement of regions of said substance through the plurality of layers is tracked to determine a flow velocity of said substance.

26. (previously presented) A method according to claim 18 wherein movement of a region of a first substance is measured, a measure of the buoyancy of said region relative to at least one other substance is determined, and the movement of said at least one other substance is measured using the movement of said region and said buoyancy.

27. (canceled)

28. (currently amended) A method according to claim 18 comprising the step of determining wherein a flow rate of at least one of the plurality of substances is determined, the flow rate being defined as the amount of said substance flowing through a predetermined region in a predetermined time.

29. (currently amended) A method according to claim 18 comprising the step of analyzing wherein a the scan data set is analyzed in two stages, wherein one stage provides providing a relatively lower spatial resolution and higher contrast resolution than the other.

30. (currently amended) A method according to claim 29 further comprising the step of identifying wherein the higher spatial resolution analysis is used to identify volumes of a first of said substances using the higher spatial resolution analysis and using the higher contrast analysis is used to distinguish between volumes of two further substances.

31. (currently amended) A method according to claim 30 further comprising the step of using wherein the high spatial resolution analysis is used to adjust a measure of X-ray attenuation of volume elements defined in the low spatial resolution analysis, to account for the presence in said volume elements of the first substance.

32. (currently amended) A method according to claim 18 further comprising the step of placing wherein the scanner is placed around a pipe to measure the movement of the substances through the pipe.

33. (cancelled)
34. (cancelled)
35. (new) The apparatus according to claim 1 wherein the control means uses a higher spatial resolution analysis to identify a volume of a first substance.
36. (new) The apparatus according to claim 1 wherein the control means uses a higher contrast resolution analysis to distinguish between a volume of a first substance and a volume of a second substance.
37. (new) The apparatus according to claim 1 wherein the control means uses a high spatial resolution analysis to adjust a measure of X-ray attenuation of volume elements defined in a low spatial resolution analysis to account for the presence in said volume elements of a first substance.
38. (new) The apparatus according to claim 1 wherein the control structure generates a high resolution image comprising a plurality of pixels.
39. (new) The apparatus according to claim 38 wherein the high resolution image is segmented.
40. (new) The apparatus according to claim 39 wherein a binary segmentation process is used to segment the high resolution image.
41. (new) The apparatus according to claim 38 wherein the high resolution image is segmented to determine which of said pixels represent a gas phase and which of said pixels represent a liquid phase.